

# **Synchrophasor Data and State Estimation**

***NASPI Workshop -- MISO***

March 25, 2015

# Outline

- **MISO System Overview**
- **MISO State Estimation**
- **MISO PMU Overview**
- **Current Status and Ongoing Tasks with PMU Data in MISO State Estimation**
- **Challenges of Current MISO SE and Potential Usage of PMU Data**



# Current Scope of Operations

- **Generation Capacity**

- 177,160 MW (market)
- 252,809 MW (reliability)

- **Historic Peak Load**

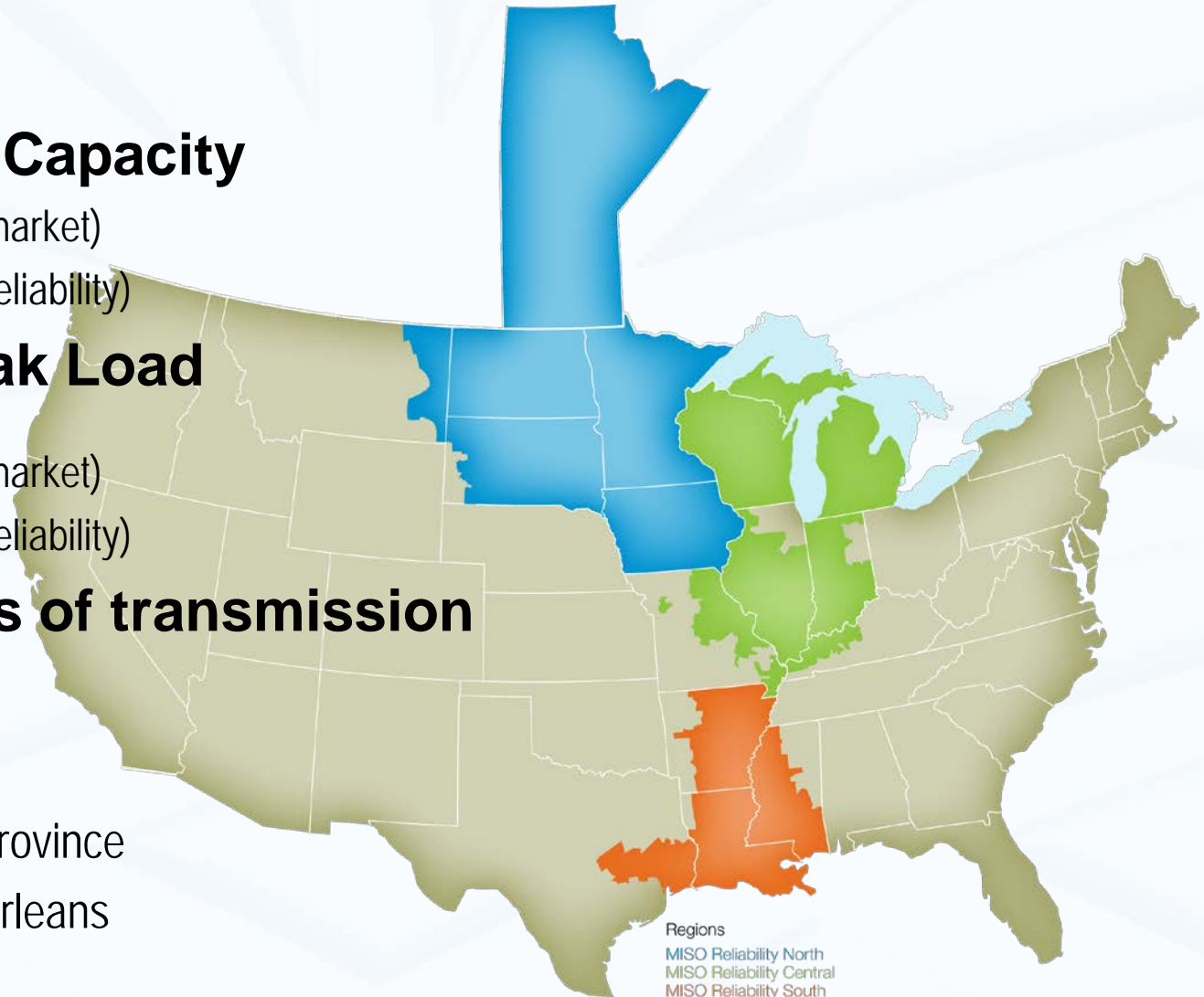
(July 20, 2011)

- 126,337 MW (market)
- 132,893 MW (reliability)

- **65,800 miles of transmission**

- **Footprint**

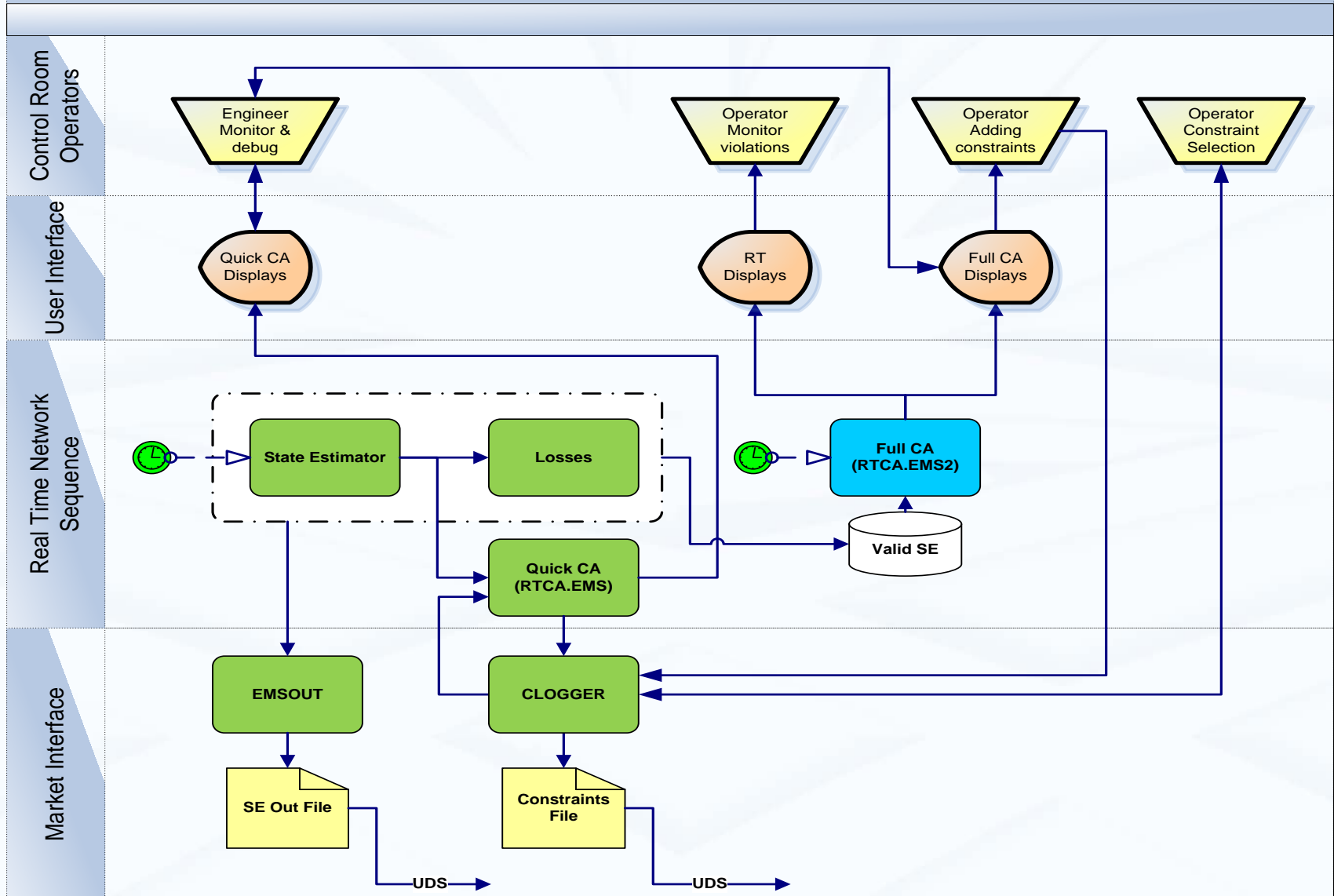
- 15 States
- 1 Canadian Province
- City of New Orleans



# MISO Network Model Overview

- **Network Model (March 2015)**
  - 54,433 network buses
  - 54,415 network branches
  - 6,332 generating units
  - 29044 substations
  - 36,777 loads
  - 228673 CBs
  - 7906 CPs
  - 289,491 Mapped ICCP points

# Real Time Network Sequence

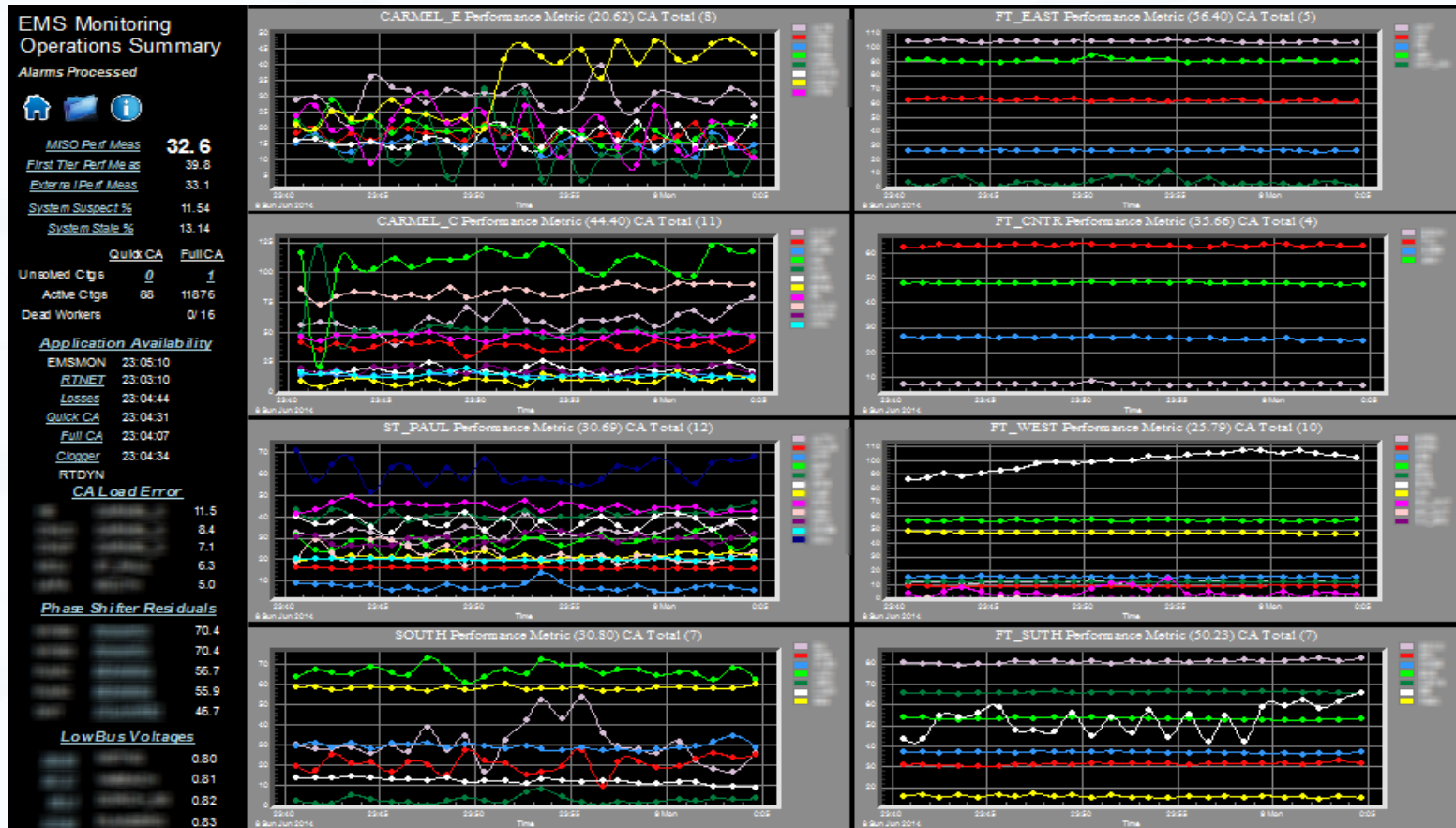


# State Estimator

- Base platform is Alstom EMP 2.6: Customized to handle the model size, performance, and to provide inputs to market related applications
- Real Time Network Analysis (RTNET) includes SE and Loss Sensitivity Calculations (Losses)
- SE, Losses run in sequence
- EMSOUT, RTCA (QuickCA) are triggered after valid SE. SE continues to run while RTCA is running
- RTNET is triggered every 60 seconds, SE solves in about 17 sec, and Losses takes about 7 sec, QuickCA takes about 28 sec.
- FullCA is triggered every 4 minutes and takes about 3 minutes to process 12000 contingencies.

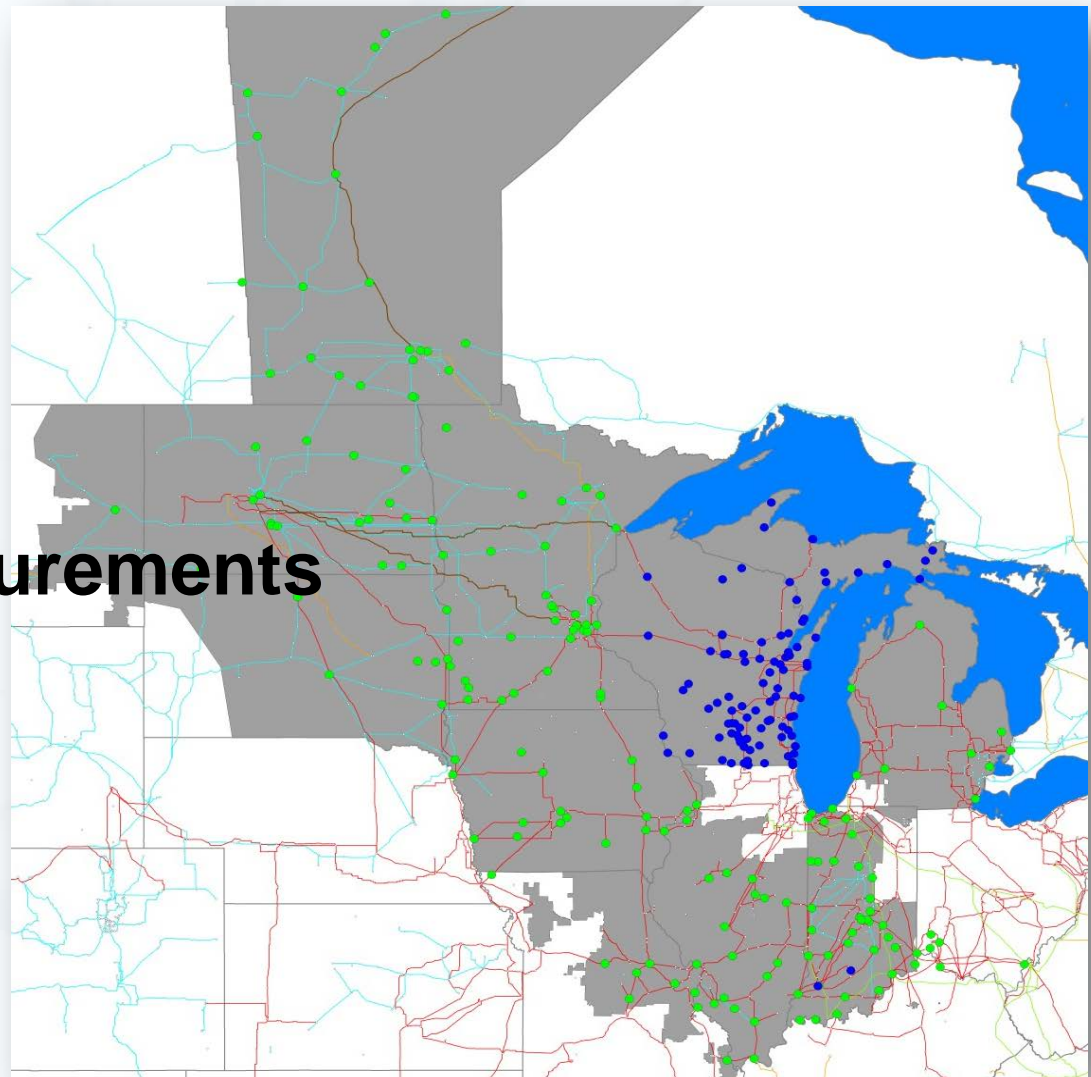
# State Estimator Performance Monitoring

- Over all SE solution quality is rolled into a single **performance index** with capability to zoom in by control area and by type of the problem
- Performance index is a weighted average of line residuals, bus mismatches, MW Anomalies, and area load errors

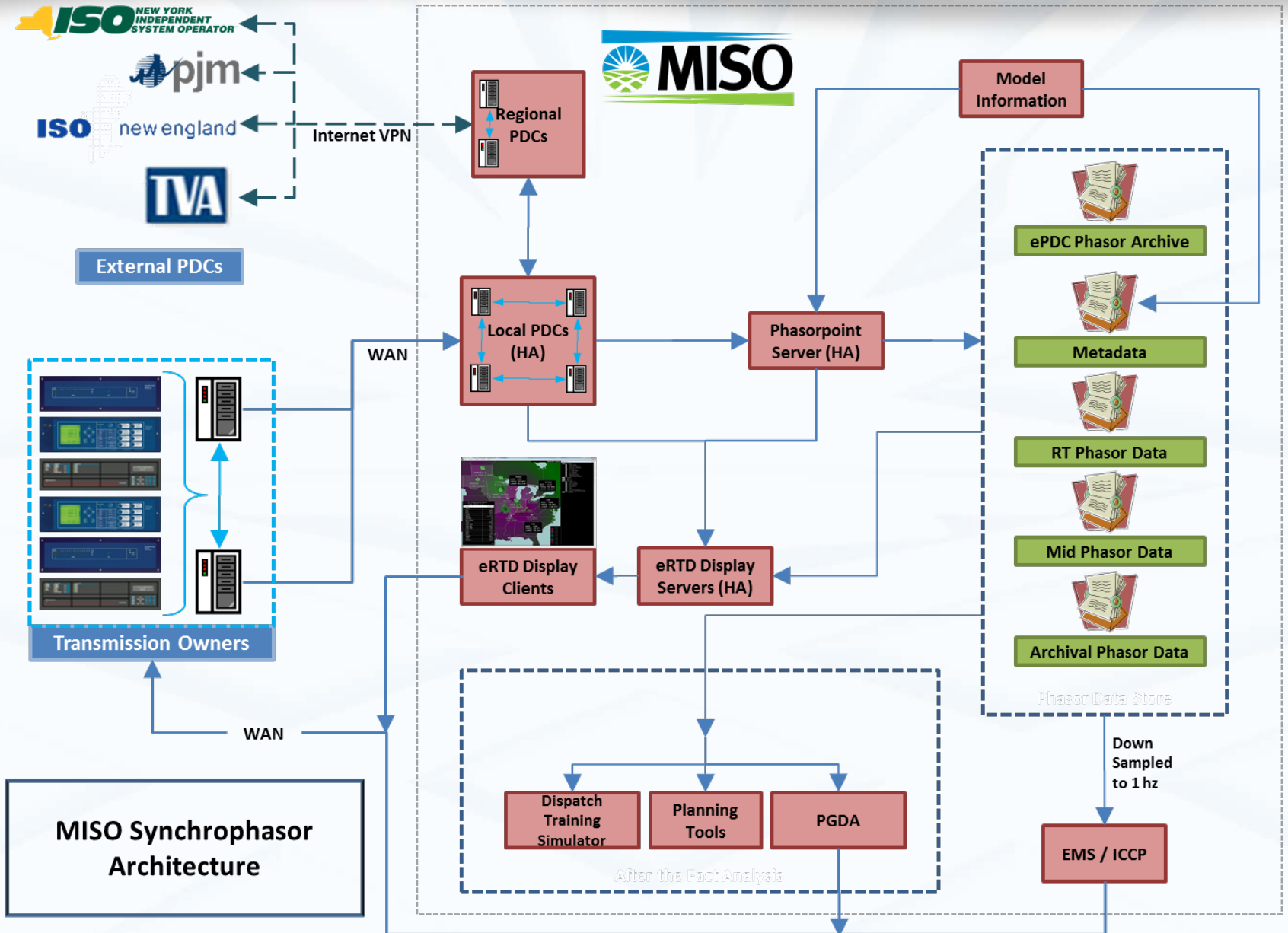


# MISO PMU Coverage

- **379 PMUs**
  - 260 Grant
  - 119 Non-MISO Grant
- **288 locations**
  - 180 Grant
  - 108 Non-MISO Grant
- **2,225 PMU measurements**
  - 583 PMW/PMR pairs
  - 522 KV/Angle pairs
  - 5 AMP/Angle pairs
  - 5 Hz







# Current Status and Under-going Tasks with PMU Data in MISO State Estimator

## Current Status

- ❖ All the MISO PMU are currently transferred from PDC to SCADA with 1 sec sampling through ISD link
- ❖ The differences between PMU bus angle measurement and SE angle solution are monitored as part of the SE performance monitoring tool

## Ongoing Tasks

- ❖ Feed PMU data into the Parallel State Estimator to test and tune SE solutions
- ❖ Evaluate the effect of PMU data on State Estimator. Decide to use PMU as Primary or Backup measurements of SE

# Challenges of Current MISO SE and Potential Usage of PMU Data

## Challenges

- ❖ Huge model size. SE solution issue in one local area will affect the entire system
- ❖ Incorrect or inaccurate network parameters (Line or transformer R, X and B)

## Potentials

- ❖ Hierarchical or Distributed SE. Use PMU data around the boundary of the sub-systems (sub-areas) to prevent the corruption of the SE solution from one area to other area(s), easy to split the sub-areas
- ❖ Parameter Estimation with PMU measurements.
- ❖ Linear State Estimation.

